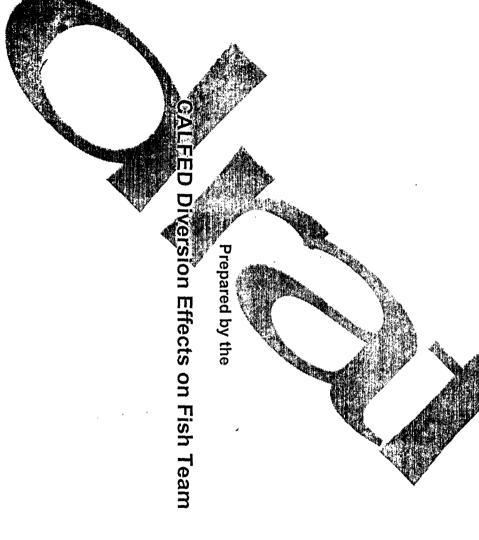
# Diversion Effects on Fish

Evaluation of a Revised



September 28, 1998

# **EXECUTIVE OVERVIEW**

#### Introduction

An interagency/stakeholder Diversion Effects on Fish Team (DEFT) was formed to address the technical issues related to diversion impacts on fisheries for CALFED. DEFT initial task was the review and evaluation of the Phase II alternatives. The results of that review were presented in a June 25, 1998 draft report prepared by DEFT.

Upon review of that report the CALFED Policy Group asked DEFT to consider various options to improve the through-Delta alternatives and develop an improved alternative that would significantly increase the likelihood for recovery of threatened and endangered Delta fish species, while considering water supply costs. With that direction, the DEFT looked at structural and operational actions that would benefit fish and potentially lead to recovery of threatened and endangered fish. These options were developed and refined through a process of comparing effects of actions in the Delta, upstream, and in coastal waters with each of the original alternatives.

#### **New Scenario**

The DEFT developed a new scenario consisting of a preliminary array of in-Delta, upstream, and coastal (harvest restrictions) actions that would improve the performance of a through-Delta alternative using criteria developed for the June 25 report. These actions plus a small array of actions developed by the CALFED Operations Group's NoName Team were combined into this new scenario and analyzed by the DEFT subteams for salmon, striped bass, and delta smelt. A description of the scenario and the results of the analysis are presented in this report.

The basic premise of the new scenario is that when high densities of vulnerable life stages of fish and other aquatic organisms are present within the significant zone of influence of the pumping plants, high entrainment rates and potential population-limiting losses could result. Reducing exports at such times when high losses are likely to occur, as indicated through appropriate monitoring, will significantly reduce the likelihood of population-limiting losses. Increasing exports at times of low adult equivalent losses will increase water in storage for all purposes including environmental protection. Coupled with this scenario is the principle of an environmental water account that would allow banking of water saved.

Water export operating constraints should be based on documented population-level effects to species of interest. Until such time as such relationships can be documented, a protective approach such as defined above for the new scenario is warranted.

The new scenario developed and evaluated represents an initial attempt at improving a through-Delta alternative and does not necessarily meet all CALFED Program objectives and principles at this time. As with the June report, this report and its recommendations should be interpreted cautiously, recognizing the scenario evaluated is only a starting point from which further refinements in structures and operations is possible. Not all DEFT members agree with the analytical methods employed, or the conclusions reached. Some of the most important areas of disagreement have been highlighted in this report. Furthermore, DEFT does not recommend this

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scenario as the CALFED preferred alternative.

There were four primary conceptual features DEFT wanted for early implementation in the through-Delta scenario:

- 1. Improved survival at south Delta pumping plant fish facilities including elimination of predation in the Clifton Court Forebay.
- 2. Abilities to close off channels from the San Joaquin and Sacramento Rivers into the south Delta and central Delta, respectively, to allow salmon and other anadromous fish a clear passage to the lower estuary.
- 3. Further reductions in spring exports to protect San Joaquin salmon and delta smelt.
- 4. Increased winter-spring outflow or X2 to improve fish migration cues and estuary habitat.

DEFT also wanted an ability to evaluate the potential effects on fish of a Hood diversion facility on the Sacramento River in the event such a facility is constructed by CALFED after the initial Stage 1 evaluation period.

The scenario developed includes structural and operational features that a majority of DEFT members felt would improve chances of recovery of key species. Some of these actions are included in CALFED's Stage 1 Ecosystem Restoration Program recommendations.

#### Structural Actions:

- A new Tracy Demonstration/Testing Fish Screen and Handling Facility capable of screening 2,500 cfs at 0.2 fps through-screen velocity and 5,000 cfs at 0.4 fps through-screen velocity. (Operational criteria and assurance to be developed.)
- A new Clifton Court Screen and Handling Facility at the northeast entrance to Clifton Court Forebay capable of screening 6,000 cfs at 0.2 fps through-screen velocity and 12,000 cfs at 0.4 fps through-screen. (Though capacity of the Banks Pumping Plant is 10,300 cfs, future options may involve joint diversions through Clifton Court; wherein total diversions may exceed 10,300 cfs.) (Operational criteria and assurance to be developed.)
- A Head-of-Old-River Barrier (Gates) on the San Joaquin River at the head of Old River as described in the Interim South Delta Program (ISDP) and CALFED alternatives.

In addition, DEFT recommends the following additional structural action in Stage 1.

• A new Hood Diversion Demonstration/Testing Facility on the Sacramento River capable of diverting up to 2,000 cfs from the Sacramento River to the Mokelumne River.

## Operational Actions:

DEFT also recommends the following specific operational actions for evaluation in Stage 1:

Lower export-to-inflow ratios from late fall through spring and higher summer ratios than

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prescribed in the 1995 Water Quality Control Plan.

- VAMP program expanded from 30 to 61 days of export limitation including all of April and May.
- February to June X2 location per 1962 level of development rather than as prescribed in the 1995 Water Quality Control Plan.
- Closure of the Delta Cross Channel from November through June except as needed to protect interior Delta water quality.
- Flexible operations allowing changes in inflow, conveyance pathways, and export levels from present standards, in combination with an Environment Water Account that would allow banking of water saved.

#### Harvest Actions:

The following are specific Stage 1 harvest management actions. Note that DEFT recognizes that many regulatory actions available to fisheries managers are likely to result in additional restrictions on ocean, estuary, and river fishing and harvest. These regulatory actions would be inconsistent with the CALFED solution principle of no significant redirected impacts.

- 1. Evaluate the feasibility of further structuring ocean fisheries to avoid impacts on weak stocks. Requires expanded tagging and recovery program, cwt tag recovery data analysis, and development of DNA microsatellite markers.
- 2. Evaluate the feasibility of selective harvest of hatchery stocks by evaluating marking hatchery fish, restrictions on fishing methods that have high hooking mortality rates, and abundance of hatchery fish at times and locations in coastal and inland fisheries. Requires expanded tagging and recovery program, cwt tag recovery data analysis, and DNA microsatellite marker analysis.

#### Habitat Actions:

The following are specific Stage 1 habitat restoration actions.

- 1. Restore tidal freshwater, riparian and seasonal and permanent wetland habitat in the area of the proposed Yolo Bypass National Wildlife Refuge including Prospect, Liberty, and Little Holland island-tracts, and tidal portions of the Yolo Bypass.
- -2. Create large areas of shallow tidal wetland habitat in the vicinity of Suisun Bay, Sherman Lake, and Big Break.
- 3. Restore and rehabilitate riparian and SRA habitat along all practicable reaches of major fish migration corridors including the Sacramento River, the San Joaquin River, Georgiana Slough, and Steamboat Slough.

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- 4. Restore and rehabilitate riparian, SRA, tidal freshwater, and seasonal and permanent wetland habitats along the North and South Forks of the Mokelumne (including dead-end sloughs of the Eastern Delta) to bolster migration and rearing of salmon from the Mokelumne and Consumes rivers.
- 5. Restore the habitat corridor of the lower Consumes and Mokelumne rivers within and above the Delta including floodplain, riparian, SRA, and wetland habitats to bolster salmon populations in these rivers.
- 6. Restore a large area of tidal freshwater, riparian, and marsh habitat in the South Delta as a pilot project to test concept of interceptor habitat.
- 7. Restore tidal freshwater, riparian, and marsh habitats along the lower San Joaquin River between Stockton and Mossdale as a pilot project to test tidal river floodplain restoration.
- 8. Restore freshwater, riparian, SRA, and marsh habitats in the floodplain of the Sacramento River below Sacramento as a pilot project.
- 9. Restore Frank's Tract's fish habitat values including creation of a broad expanse of shallow water and wetland habitats within the tract.
- 10. Evaluate habitat restoration options in the non-tidal portion of the Yolo Bypass that are consistent with its present flood control and agricultural uses.

## Water Supply Actions:

In addition to the above actions for fish recovery, the following water supply actions being evaluated by the No-Name Group were included in the model runs evaluated by the DEFT. These features were included in original evaluations for other alternatives and were included here to provide a consistent basis for comparisons of alternatives. The DEFT has not evaluated the affects of these actions except to the extent they were a component part of the modelled scenario. Since the DEFT has not evaluated the effects of these actions, it does not recommended these actions.

#### NoName Actions included in Scenario:

- South Delta salinity control structures.
- Expanded Banks pumping capacity (to 10,300 cfs).
- Enlargements or dredging of Old River (South Delta).
- CVP and SWP intertie south of the Delta.
- Madera Ranch Ground Water Storage Project.

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#### Scenario Assessment

The following are the preliminary assessments of the new scenario developed by DEFT species teams.

The salmon team evaluated the contribution of the new scenario to in-Delta survival of Sacramento River, San Joaquin River, and Eastside tributaries, as well as the effects of proposed upstream and harvest-management actions. Compared to Alternative 1, the salmon team's assessment of the proposed scenario indicated relatively little change in Delta conditions for Sacramento salmon, and moderate improvements for San Joaquin and Eastside tributaries. Improvements were attributed to reduce exports and improved flow distribution in the Delta, particularly for San Joaquin salmon. Some of these benefits were offset by exposure to the screen at the Hood diversion (Sacramento fish), or detrimental flow conditions resulting from outflow of the Hood diversion (Eastside tributaries salmon). Given the experimental nature of the screen facility at Hood and the potential negative impacts on specific fishery resources, it is imperative that a comprehensive monitoring effort focused on determining the impacts of the Hood screen on Sacramento and Eastside tributary salmon be implemented coincidental with the construction of this facility. Upstream and harvest-management actions, that are the same across all alternatives and the new scenario, provided a larger proportion of total benefits of the CALFED program than Delta actions. The combined evaluation of all components of the CALFED program suggests a moderate probability of achieving program goals for all runs of salmon, with San Joaquin fall run having slightly less probability of successful restoration than the other runs.

The **striped bass** team concluded that actions in the new scenario would likely provide greater potential for recovery than Alternatives 1 and 2, or existing conditions, and help to restore the adult population to historic levels. However, concerns remain for continuing south Delta exports, higher summer export/inflow ratios, blockage of adult striped bass within the Hood facility, greater net upstream flows (when average over a tidal cycle) in the south Delta toward the pumping plants, and continued exports from the south Delta.

The delta smelt team concluded that the new scenario would improve chances of recovery over that of Alternatives 1 and 2, or existing conditions, however uncertainty associated with this evaluation is extremely high. Whereas Alternatives 1 and 2 provided moderate improvements compared to existing conditions through benefits derived from the Common Programs, the new scenario provides additional benefits in the form of additional export restrictions in dry years beyond the Common Programs that would help the population toward recovery. Concerns remain for the potential negative effects of greater net, tidally averaged, upstream flows in the south Delta toward the pumping plants and continued exports from the south Delta. The new screen systems in the south Delta would offer little benefit to delta smelt, unlike striped bass and salmon who have high salvage survival. Likewise the south Delta barriers of the ISDP potentially would adversely affect delta smelt by drawing more smelt from the central Delta into the south Delta. The degree of potential benefit from the new scenario would be highly variable depending on the timing and degree to which the Common Programs are implemented.

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# 1. INTRODUCTION

An interagency/stakeholder Diversion Effects on Fish Team (DEFT) was formed to address the technical issues related to diversion impacts on fisheries for CALFED. DEFT's initial task was the review and evaluation of the Phase II alternatives. The results of that review were presented in a June 25, 1998 draft report prepared by DEFT.

Upon review of that report the CALFED Policy Group asked DEFT to consider various options to improve the through-Delta alternatives and recommend an improved alternative that would significantly increase the likelihood for recovery of threatened and endangered Delta fish species. With that direction, the DEFT looked at structural, operational, habitat, and harvest actions that would benefit fish and increase the potential for recovery of threatened and endangered winter run chinook salmon and delta smelt, as well as unlisted salmon, splittail, striped bass, and other fishes.

The DEFT developed a preliminary array of actions that the majority of DEFT felt would improve the performance of a through-Delta alternative using criteria developed for the June 25 report. These actions plus a small array of actions developed by the CALFED Operations Group's NoName Team were combined into a new scenario and analyzed by the DEFT. A description of the scenario and the results of the analysis are presented in this report.

As with the June report, this report and its recommendations should be interpreted cautiously, recognizing the scenario evaluated is only a starting point from which further refinements in structures, habitat, harvest, and operations is possible. The scenario developed and evaluated represents an initial attempt at improving a through-Delta alternative and does not necessarily meet all CALFED Program objectives and principles at this time, nor does it have the full support of either the DEFT or No-Name Group or the teams' members. Also the evaluation of the scenario has only involved effects on three species of fish: chinook salmon, delta smelt, and striped bass, and thus may not reflect impacts to other species. Other important species that may be affected by changes in delta conditions, but whose responses may differ from the species analyzed here, include: green sturgeon, white sturgeon, longfin smelt, Sacramento splittail, and American shad. CALFED may need to develop a future analysis to address these species.

This report presents progress toward developing an improved through-Delta alternative and should not be considered anything other than an initial attempt at an improved alternative. Efforts continue at evaluating and revising actions, and improving evaluation methods. This report summarizes the DEFT organization, the evaluation process, and the tentative conclusions reached by the species teams and the majority of the full DEFT.

# **Team Organization**

Members of the DEFT are listed below under the species team on which they primarily served. Some participated in several teams. Several people contributed to the species teams that are not

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on the DEFT. They are identified with an (\*).

#### Salmon Team

Patricia Brandes (co-chair), U.S. Fish and Wildlife Service Shelia Greene (co-chair), Department of Water Resources Serge Birk, Central Valley Project Water Association Pete Chadwick, Department of Fish and Game Karl Halupka, U.S. National Marine Fisheries Service Jim White, Department of Fish and Game Joe Miyamoto, East Bay Municiple Utilities District Terry Mills, CALFED staff

## Striped Bass Team

Lee Miller (chair), Department of Fish and Game \*David Kohlhorst, Department of Fish and Game Kevan Urquhart, Department of Fish and Game \*Don Stevens, Department of Fish and Game

#### **Delta Smelt Team**

Dale Sweetnam (co-chair), Department of Fish and Game Larry Brown (co-chair), U.S. Bureau of Reclamation Michael Thabault, U.S. Fish and Wildlife Service

## Harvest Management Team

Joe Miyamoto (Acting Chair), East Bay Municipal Utility District
Dan Viele, National Marine Fisheries Service
Gary Stern, National Marine Fisheries Service
LB Boydstun, California Department of Fish and Game
Alan Baracco, California Department of Fish and Game
Zeke Grader, Pacific Coast Federation of Fishermen's Association
Bill Kier, Consultant for Pacific Coast Federation of Fishermen's Association
Peggy Beckett, Golden Gate Fishing Association
Roger Thomas, Charter Boat Fishing Association
Rick Sitts, Metropolitan Water District of Southern California
Jim Buell, Consultant for Metropolitan Water District of Southern California
Terry Mills, CALFED staff
Serge Birk, Central Valley Project Water Association

#### DEFT members not on a specific species team

Bruce Herbold, U.S. Environmental Protection Agency Pete Rhoads, Metropolitan Water District Southern California Michael Fris, U.S. Fish and Wildlife Service Jim Buell, Metropolitan Water District Southern California Elise Holland, Bay Institute

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Ron Ott, CALFED

# Goal and Objectives

The original review of the program alternatives found various problems (impacts) associated with the through-Delta alternatives (see DEFT June 25, 1998). The goal of this latest endeavor was to eliminate or reduce the problems identified via an array of new or revised actions that the majority of the DEFT felt would pose less risk to and a higher potential for recovery for key species.

To meet this goal, the team developed a series of objectives based on identified hypotheses regarding factors that control fish populations and their production and/or survival in the Delta. There were some differences of opinion among DEFT members regarding the validity or relative importance of certain underlying hypotheses. The principal difference of opinion revolves around the issue of whether net flows or monthly average conditions (for example, Q-West, net Delta outflow, net negative flows in certain delta channels, net monthly average San Joaquin flows at Antioch, etc.) are satisfactory indicators of environmental conditions influencing the production and/or survival of fish in the delta.

A majority of the DEFT members felt that average condition parameters are good indicators of aquatic environmental conditions. A minority of members felt that, since net flows are a very small fraction of tidal flows throughout the great majority of the Delta and, since they do not reflect habitat and hydrodynamic conditions actually experienced by aquatic organisms, including fish, these flows are extremely poor indicators of habitat conditions and are not appropriate for protective standards or criteria or for biological analysis. The minority felt that real-tide Delta channel velocities (both ebb and flood) and other local physical and biological habitat conditions would be greatly superior tools for biological analysis, and should have been used instead of the average condition parameters. The minority felt that since tidal velocities in most delta channels are two orders of magnitude greater than net velocities, and since water velocity and water residence time (both of which can be modeled) are the hydrodynamic parameters most directly influencing fish and other aquatic organisms, comparing real-tide hydrodynamic conditions that would prevail for each alternative in various locations throughout the delta would give a much more accurate indication of differences among alternatives and would also lead to discovery of specific measures to improve hydrodynamic and physical habitat conditions on both gross and local scales. The majority argued successfully that this approach would be new and should therefore not be taken.

The goals adopted by the DEFT reflecting the majority perspective are given below, along with their underpinning hypotheses. Where appropriate, a minority hypothesis related to the goal is also given for perspective. Alternative goals are implicit in minority hypotheses.

- 1. Improve Delta Hydrodynamics
  - a. Improve net flows west from the Central Delta (QWEST).

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- (Majority Hypothesis: Net positive flows from the Delta would help reduce risk of fish moving toward and into the south Delta where they are subject to export and move them to their historical rearing areas.) (Minority Hypothesis: Net flows are a very small fraction of tidal flows throughout the great majority of the Delta and do not represent conditions actually experienced by aquatic organisms, including fish. The best approach is to improve local velocity fields, residence time and physical habitat conditions.)
  - b. Improve Delta outflow as measured by average X2 location in the Bay and Delta.

(Majority Hypothesis: Production of a variety of fishes and their food web is enhanced through a variety of processes when X2 is located farther downstream.) (Minority Hypothesis: X2 is not a satisfactory surrogate for the many factors which may be related to fish survival, because of uncertain synergies and/or antagonisms, among other factors. The relationships and relative importance of various factors to fish and to each other may change with altered conditions attending each alternative. The best approach would be to identify specific factors influencing aquatic resources and their modes of action and address them directly.)

- c. Reduce negative flows in the south Delta toward the pumping plants at key times of the year.
- (Majority Hypothesis: Negative flows in the Old and Middle River channels in the south Delta are believed to influence the zone of influence of the pumping plants.) (Minority Hypothesis: Clifton Court Forebay gates are generally opened at high tide, and the hydrodynamic influence of these events is propagated outward and is felt primarily as a slight reduction in maximum ebb velocity. Therefore, the most effective means to promote production and reduce mortalities of aquatic resources within the zone of significant influence of the pumping plants is to increase overall water residence time in the Delta to allow for hatching and growth of early life stages and to implement significant interconnected habitat enhancement measures throughout the Delta, emphasizing conveyance corridors, to facilitate organism/habitat associations and food web interactions.)
- d. Improve flows in the lower San Joaquin River in April and May. (Majority Hypothesis: San Joaquin River salmon would benefit from higher transport flows in April and May, their key outmigration period. The existing VAMP period of 30 days of increased flows and lower exports does not adequately protect outmigrating salmon from San Joaquin tributaries.) (Minority Hypothesis: VAMP is an experiment which has not yet been conducted and from which conclusions cannot yet be drawn. Furthermore, data analyses on the relationship between export/inflow ratios and San Joaquin salmon protection do not show a relationship between adult production (harvest

plus escapement) and Vernalis flows. The greatest protection for San Joaquin salmon can be provided through the installation of an operable barrier at the head of Old River capable of operating at as high a Vernallis discharge as practicable, and the use of this and near-real-time "flexible operations" to maximize salmon smolt protection while maintaining water reserves for environmental and other benefits.)

# 2. Improve Migration Pathways for Fish

- a. Reduce the potential for movement of outmigrating juvenile San Joaquin salmon into the south Delta via the Head of Old River.

  (Majority Hypothesis: Survival of outmigrating San Joaquin salmon is much lower even in wetter years if they pass into the Delta via the Head of Old River.)

  (Minority Hypothesis: Survival of outmigrating San Joaquin salmon is much higher if they are not subjected to entrainment, salvage, transportation and release as a consequence of passing directly in front of the pumping plants, and anything that can reduce direct exposure to entrainment, such as a barrier at the head of Old River which can be operated over a wide range of Vernalis flows, will improve survival of these fish.)
- Reduce the movement of juvenile Sacramento River salmon into the interior Delta via the DCC and/or Georgianna Slough. (Majority Hypothesis: Survival of salmon smolts migrating from the Sacramento system via the Delta Cross Channel or Georgianna Slough is substantially less than those that remain in the Sacramento River channel.) (Minority Hypothesis: The hypothesis that survival of juvenile salmon entering the Delta is significantly depressed relative to those which do not enter the central Delta is greatly overstated. Recovery prospects of naturally-produced salmon stocks will be greatly enhanced over existing conditions by improving habitat, food web and predator/prey relationships within the interior Delta, and recovery may not be able to occur absent these improvements. Within the central Delta, large, interconnected acreages of gently sloping, vegetated intertidal areas with many distributary channels, among other things, will provide excellent rearing and migratory habitats with ample refugia for juvenile salmon derived from the Sacramento River and its tributaries as well as eastside tributary streams, and will accelerate recovery of these stocks.)

#### 3. Reduce Exports

a. Reduce exports at key times of the year.

(Majority Hypothesis: High export rates in winter and spring appear to reduce survival of important fish.) (Minority Hypothesis: Water export constraints should be made on the basis of population-level effects. High export rates in the presence of high densities of

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vulnerable life stages of fish and other aquatic organisms near the pumping plants results in high entrainment rates and potential population-limiting losses. Reducing exports at times when entrainment rates leading to high adult-equivalent losses are likely to occur, as indicated through near-real-time monitoring, will significantly reduce the likelihood of population-limiting losses.)

b. Reduce the export to inflow ratio in fall and winter.

(Majority Hypothesis: Higher export/inflow ratios in fall and winter in recent decades are associated with declining populations of winter run and late-fall run chinook salmon and delta smelt.) (Minority hypothesis: Relationships between export to inflow ratios and population strength of winter run and late-fall run chinook salmon and Delta smelt are either non-existent or extremely weak and may be spurious. For salmon, decreasing export to inflow ratios did not have an effect on total adult returns, whereas harvest restrictions implemented for the protection of winter run chinook did have salutary effects on this and other salmon stocks. Continued progressive harvest management and near-real-time "flexible operations" coupled with an aggressive Real Time Monitoring Program, including aggressive development of better monitoring methods for Delta smelt, would be a superior method to afford protection for these species.)

#### 4. Reduce Entrainment Losses

a. Reduce losses of juvenile fish at Tracy and Clifton Court Forebay fish facilities.

(Majority Hypothesis: Existing fish facilities are inefficient and cause significant loss to predation in the forebay and to mortality of salvaged fish in handling and trucking.) (Minority Hypothesis: The best way to reduce excessive pre-louver predation, separation, handling, transportation and post-release predation losses associated with the operation of the pumping plants is to expeditiously install modern, well-designed and well-maintained screening, separation, sorting, holding, transportation and release facilities at both the CVP and the SWP, with the screening facilities at the SWP located at the entrance to CCFB. This should be coupled with an aggressive, focused predator reduction program in specific problem areas, especially along migration corridors.)

b. Reduce losses of fish at other Delta diversions (Hypothesis: Eggs, larvae, and juvenile fish are lost in large numbers to Delta diversions.)

# 5. Improve Delta Habitat

a. Make habitat in the Delta more fish friendly.
(Majority Hypothesis: A through-Delta alternative should require improved habitat in the central and south Delta to not only slow fish movement toward pumping plants, but to increase food supply and fish growth and survival, which are adversely affected by south

Delta exports.) (Minority Hypothesis: A through-Delta alternative should require improved habitat in the central and south Delta to not only slow fish egg and larval dispersal toward pumping plants to allow these life stages to mature, but to increase food supply and fish growth and survival, and facilitate fish/habitat relationships which may be otherwise adversely affected by changes in tidal hydrodynamics attributable to south Delta exports.)

- b. Create more shallow water, riparian, and wetland habitat in the Delta. (Hypothesis: Survival of key fish species would be enhanced with more spawning and rearing habitat in the Delta.)
- c. Improve habitat in migration corridors (e.g. Georgianna Slough). (Hypothesis: young fish would be more likely to be retained in the corridor and less likely to be lost in interior and south Delta if habitat were improved in the migrating corridor.)

# 6. Improve Water Quality

- a. Reduce the amount of contaminants in water and sediment. (Hypothesis: High concentrations of contaminants in water and sediment reduce survival of fish in the Delta.)
- b. Reduce the amount of toxins in fish tissues. (Hypothesis: high concentrations of toxins in fish are a potential human health hazard.)
- c. Improve water temperatures. (Hypothesis: high water temperatures at certain times of the year may limit survival of some fish in the Delta.)

## 7. Improve Fish Harvest Management

- a. Review ocean harvest management. (Hypothesis: ocean harvest management may not be adequate to protect key salmon populations.)
- b. Review possible fishing regulatory actions that could contribute to recovery. (Hypothesis: the effectiveness of actions varies considerably.)

# **Approach**

To address the goal and objectives the DEFT developed specific actions that reduced or eliminated some or all of the environmental problems identified by DEFT for Alternatives 1 and 2. The DEFT consulted with the Ecosystem Restoration Program team to determine what actions were slated for short-term implementation (Stage 1). The DEFT developed various concepts for review and analysis in hydrologic and operations models developed by the Bureau of Reclamation and the California Department of Water

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Resources (DWR). DWR staff ran the operations models to determine effects of various options considered. Model output was provided for a set of key discriminating factors that relate directly to the objectives. Finally, DEFT species teams evaluated various potential actions and evaluated effects of these actions. These teams included a salmon team, a delta smelt team, and a striped bass team. A harvest team was added to evaluate ocean and other harvest effects on salmon. A habitat team designed an array of habitat improvement actions, but did not evaluate alternatives. The following discussions summarize some of the aspects of the approach including what impact parameters and discriminating factors were used by the teams and how the teams conducted impact assessments.

## **Impact Parameters**

To guide the species teams and to provide a framework for addressing issues, the DEFT developed a list of impact parameters that have direct and indirect effects on the key fish species. Each species team considered on or more of the impact parameters listed below in their assessments.

- Export losses of juvenile fish export rates at key times of the year related to potential export losses of fish at south Delta pumping plants.
- **Delta hydrodynamics** (flow magnitudes and direction) changes in Delta hydrodynamics affects fish migration, habitat, and vulnerability to export loss.
- **Predation on juvenile fish** structures and facility operations affect potential predation on key fish species.
- Handling of juvenile fish at fish facilities export losses are in part due to handling in fish recovery facilities.
- **Fish food supply** abundance of key fish prey species of invertebrates are associated with freshwater outflow from the Delta.
- Conditions for upstream migration structures and operations affect the ability of migrating fish to pass upstream through the Delta to spawning areas in river.
- Fish spawning, rearing, and migrating habitat the quality and quantity of such habitat affects fish survival and productivity in the Bay-Delta system.
- Water quality contaminants, water temperature, and salinity affect fish habitat and survival.
- Agriculture diversions the location, amount, and timing of diversions determines the degree to which fish are affected by diversions.

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• Adult fish straying from primary migration routes - migration of anadromous and other types of fish could be affected by structures and changes in hydrodynamics.

#### **Delta Flow Parameters**

To gain insight into the various impact parameters and how they varied by alternative, the assessment team relied on model predictions of the key Delta flow parameters that would be altered by structural and operational changes. Many factors, including flow, habitat and management practices, were considered by the Species Teams and the full DEFT. Those specific factors used by the species teams to evaluate DWR model output are listed below. As indicated earlier, a minority of the DEFT does not believe that these average condition parameters are good indicators of aquatic environmental conditions in the Delta and would have preferred analyses based on real-time hydrodynamics and physical habitat conditions.

- Cross-Delta Flow refers to the combined net flow from the lower Sacramento River into the Central Delta via the DCC and Georgianna Slough. (Changes in cross-Delta flow may reflect vulnerability of Sacramento River fish being drawn into the interior Delta, as well as the amount high quality (low salt content) Sacramento River water entering the Delta.)
- Sacramento River Flow below Hood increases and decreases in cross-Delta flow would correspond to decreases and increases, respectively, in the flow in the Sacramento River below the channels conducting cross-Delta flow. (Lower Sacramento River flow may be positively related to fish transport and survival.)
- QWEST the net flow from the Central Delta to the Western Delta via the lower San Joaquin and nearby channels. (Changes in QWEST may reflect ability of juvenile fish to move to western Delta and Bay rather than toward the south Delta export pumps. QWEST may also be related to foodweb productivity.)
- Lower San Joaquin River Flow at Antioch net flow in the San Joaquin channel; this factor is similar to QWEST.
- Flow in Old River near Bacon Island extremes and net flows in the lower Old River channel near Bacon Island. (Changes in flows at this location may reflect changes in the vulnerability of fish in the south Delta to being lost to south Delta export.)
- Monthly average location of X2 average monthly location of the 2 ppt salinity position in the estuary salinity gradient expressed in miles above the Golden Gate. (Changes in X2 may represent changes in foodweb productivity, low salinity habitat, and hydrological transport mechanisms that may affect fish distribution and survival.)
- Electrical Conductivity at various Delta locations EC is a measure of the extent

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of salinity intrusion and lack of dilution of high conductivity agricultural return water in the Delta. (Higher EC represents effects on water quality, water supply, and environmental values.)

- South Delta Exports and Export/Inflow Ratios a key discriminating factor among the alternatives was the magnitude and seasonal distribution of exports and the export/inflow ratio. (Exports and the export ratios have been shown to be directly related to fish abundance, distribution, and losses at the south Delta pumping plants.)
- **Delta Outflow** the magnitude and seasonal distribution of freshwater flow or net flow exiting the Delta to Suisun Bay. (Delta outflow has been shown to be directly related to abundance of key fish and fish prey.)

# Species Team Assessments - (Salmon, Striped Bass, Delta Smelt)

These impact parameters and flow parameters were used by the respective teams to evaluate the effects of specific actions and various scenarios evaluated. The species teams developed matrices on the effects of the impact parameters on the life stages of each species by month for arrays of actions. These were used by the teams to address the objectives. The detailed matrices and interpretations are described in individual species reports in appendices.

## Salmon Team Evaluation of Upstream Actions

The DEFT Salmon Subgroup was assigned the task to evaluate the upstream actions proposed in the CALFED Stage I Implementation and during the long-term Ecosystem Restoration Program. The Salmon Subgroup was to assess the degree to which upstream actions would likely contribute to the recovery of endangered species including salmon stocks proposed for listing.

In the analysis, the Salmon Team evaluated the potential benefits of restoration actions for the following stocks,

Sacramento River winter-run chinook salmon

spring-run chinook salmon

late-fall-run chinook salmon

Sacramento fall-run chinook salmon

San Joaquin fall-run chinook salmon

Mokelumne River fall-run chinook salmon (Note: The team agreed to assess Mokelumne River independently due to its connection with the Delta and potential affects of conveyance alternatives).

## Harvest Management Team Assessments

The harvest management team evaluated additional opportunities to enhance salmon and striped bass populations through harvest controls in Stage 1. They evaluated actions proposed as part of the CVPIA program and CALFED's ERP.

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# **Habitat Team Assessments**

The habitat team reviewed habitat actions in the Delta and Suisun Bay included in the ERP and prepared a specific list of measures to recommend for implimentation in Stage 1.

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# 2. SCENARIO DESCRIPTION

The DEFT developed and evaluated the new scenario consisting of a specific array of actions that could be used to meet the above defined objectives and goal of an improved through-Delta alternative. The scenario developed should be considered preliminary and results of the impact associated should be interpreted cautiously, recognizing the many informational and procedural limitations inherent in these work products. The short time frame provided for this work compelled the team to rely primarily on professional judgement to evaluate the degree to which each relevant factor affects each of the key species. Assumptions had to made that in some cases limited the team's ability to answer some issues. The actions or the full scenario may not meet all CALFED principles or objectives.

# **Basic Concept**

When high densities of vulnerable life stages of fish and other aquatic organisms are present within the significant zone of influence of the pumping plants, high entrainment rates and potential population-limiting losses could result. Reducing exports at such times when high losses are likely to occur, as indicated through appropriate monitoring, will significantly reduce the likelihood of population-limiting losses. Increasing exports at times of low adult equivalent losses will increase water in storage for all purposes including environmental protection. Coupled with this scenario is the principle of an environmental water account that would allow banking of water saved.

Water export operating constraints should be based on documented population-level effects to species of interest. Until such time as such relationships can be documented, a protective approach such as defined above for the new scenario is warranted.

# **DEFT Actions for Stage 1 Evaluation**

The proposed scenario includes actions described below by category.

#### **Structural Changes:**

1. A new Hood Diversion Demonstration/Testing Facility on the Sacramento River capable of diverting up to 2,000 cfs from the Sacramento River to the Mokelumne. The facility would have an alignment as defined for Alternatives 2 and 3, so that those options would not be precluded in the future. Screen operation would be under criteria established by NMFS, FWS, and DFG. A comprehensive monitoring program to address the potential negative impacts identified below needs to be implemented coincidentally with the operation of the test facility. The facility would be operated for the following purposes:

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- i. Test screening efficiency, cleaning and bypass mechanisms.
- ii. Test upstream passage mechanisms.
- iii. Test impacts on fish migration through the Delta.
- iv. Enable closing the Delta Cross Channel without compromising interior Delta water quality.
- v. Improve Delta water quality.
- vi. Improve cues for migrating fish.

This action also has some potential negative effects:

- Exposes young salmon to a new screen system
- May impair cues of migrating fish
- May block or impair upstream passage of migrating fish
- Depending upon the location of the conveyance to the Mokelumne, may create flow conditions that would increase the exposure of Eastside tributary (Mokelumne) salmon to the export pumps.
- 2. <u>A Barrier at the Head-of-Old-River.</u> The facility will be used for the following purposes:
  - i. Improve San Joaquin salmon survival.
  - ii. Improve water quality in lower San Joaquin River below the Barrier.

This action also has some potential negative effects:

- May impair upstream migration of San Joaquin salmon in the fall
- May increase entrainment of organisms living in the central and southern Delta
- 3. A new Tracy Demonstration/Testing Fish Screen and Handling Facility capable of screening 2,500 cfs at 0.2 fps through-screen velocity and 5,000 cfs at 0.4 fps through-screen velocity. Screen operation would be under criteria established by NMFS, FWS, and DFG. The facility would be operated for the following purposes:
  - i. Will improve survival of salvaged fish at the Tracy pumping plant.
  - ii. Will reduce entrainment at the Tracy pumping.
  - iii. Will provide valuable information for design of future fish facilities.

This action also has some potential negative effects:

- There may be some stranded costs if the point of diversion is moved sometime in the future.
- 4. A new Clifton Court Screen and Handling Facility at the northeast entrance to Clifton Court Forebay capable of screening 6,000 cfs at 0.2 fps through-screen velocity and 12,000 cfs at 0.4 fps through-screen. Screen operation would be under criteria established by NMFS, FWS, and DFG. There two primary options to consider:

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- Design the screens and low head pumping facilities to screen 6,000 cfs at 0.2 cfs approach velocity. For pumping above 6,000 cfs use a combination of the screens and the existing intake gates. Operate both the salvage facilities at the new screens and at Skinner.
- Design the screens with the capability to operate at 0.2 to 0.4 fps approach velocity and the low head pump station at 10,300 cfs. To achieve the 10,300 cfs capacity through the new screens at particular times, the approach velocity would be increased to accommodate the total flow (approach velocity around .33 cfs).

DEFT recommends that the facility be designed not to preclude either option and to continue with the research at UC Davis Treadmill and the Research work at Tracy to help guide the use of flexible criteria. The facility would be operated for the following purposes:

- i. Improve survival of fish in the south Delta near the State export pumping plant.
- ii. Reduce predation of fish in Clifton Court Forebay.
- iii. Provide constant export rates (less gulping) to reduce disruption of fish migrations and reduce exposure of fish residing in or migrating through the central and south Delta to entrainment.

This action also has some potential negative effects:

• There may be conflicts with higher pumping rates (e.g., over pumping screens or exporting water that is not first screened).

#### **Operational Changes**

- 5. Allow higher or lower export rates and changes to export-to-inflow ratios other than those prescribed by Water Quality Control Plan. Shift pumping rates seasonally and on a real-time bases such as reducing pumping when inflow is low or fish are present in large numbers, or increasing pumping when outflow is high or few fish are present in the south Delta. Greater flexibility, both seasonally and in real-time appears to be possible and has good potential to provide greater environmental protection. An environmental water account might function to keep track of pumped and stored water that could become credits against pumping at critical environmental periods. The export rates could be altered for the following purposes:
  - i. Reduce entrainment.
  - ii. Improve foodweb productivity.
  - iii Protect fish migrating through the Delta.

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This action also has some potential negative effects:

- Impacts may shift to other species or life stages.
- May locally impact water quality.

The export rates would be managed in the following ways:

#### Seasonally:

- More restrictive at times, providing greater environmental protection.
- Less restrictive at times, providing water for environmental benefit at later more critical periods.
- Shift high pumping to seasons of high flows, especially high San Joaquin flows
- Shift high pumping to seasons of low fish sensitivity Current requirements in the WOCP and Biological Opinions require seasonal adjustments in operations, modified by hydrological patterns. Further protection to allow recovery may need to expand on these tools. Seasonal shifts in operation may be most appropriate for conditions that occur predictably or where the times of sensitivity overlap for several species. Examples of such seasonal responses that the DEFT has considered include: increasing the period of the Vernalis Adaptive Management Program from 31 to 60 days and relaxation of the Export/Inflow ratio to 75% in August and September.

# **Operational Flexibility-Monitoring Response:**

- More restrictive at times, providing greater environmental protection.
- Less restrictive at times, providing water for environmental benefit at later more critical periods.
- Shift high pumping to periods of high flows, especially high San Joaquin flows
- Shift high pumping to periods of low fish sensitivity
- 6. Modify flow volumes, distributions, frequency, and pathways. Flows may be changed by altering inflows, exports, barriers (e.g., DCC, Head of Old River barrier, Montezuma Slough salinity barrier, etc.). Flow would be altered for the following purposes:
  - i. Reduce entrainment.
  - ii. Improve foodweb productivity.
  - iii. Improve fish migrating cues.
  - Protect fish migrating through the Delta.
  - Improve fish habitat (e.g., alter salinity, water temperature, inundate v. floodplain).
  - vi. Improve water quality - (e.g. reduce concentrations of toxins, areas of low dissolved oxygen).

This action also has some potential negative effects:

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October 1, 1998

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